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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 15 1994

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Note to: Addressees

Attached you will find a copy of the long-awaited Section 403 Interim Lead Hazard Guidance and the OSWER Soil Directive.

Many, and perhaps most, of you have commented on this effort over the past two years. Some of you have contributed lengthy and thoughtful comments which have helped us to develop the best possible public guidance we can offer at this time. I realize that there is still more work to be done over the next year or so to develop final health-based standards, and look forward to your continued assistance and comment in that effort.

I want to offer my personal thanks and the thanks of all of us at EPA for your help in completing this difficult task.

John W. Melone
Director
Chemical Management Division

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 14 1994

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: Guidance on Residential Lead-Based Paint, Lead-Contaminated Dust, and Lead-Contaminated Soil

FROM: Lynn R. Goldman, M.D. Lynn R Goldman
Assistant Administrator

TO: See Below

Recently, the Agency has received an increasing number of requests for advice on residential lead-based paint hazards which, by statutory definition, includes hazards from lead-contaminated dust and soil in and around homes. These requests have come from State and EPA Regional officials, as well as public health and housing personnel. While the Agency is in the process of developing a rule to address these hazards under Section 403 of the Toxic Substances Control Act (TSCA), 15 USC §2683, we believe that it is prudent to respond to these requests by issuing guidance at this time based upon our best currently available information.

The attached recommendations will serve as guidance until the promulgation of the section 403 rule. Depending upon the results of ongoing studies, we may revise the numerical values, particularly for dust, in additional guidance prior to the section 403 rulemaking.

Addressees:
Director, Air Management Division, Region 1
Director, Environmental Services Division, Region 2
Director, Air, Toxics, and Radiation Management Division, Region 3
Director, Air, Pesticides, and Toxics Management Division, Region 4
Director, Environmental Sciences Division, Region 5
Director, Air, Pesticides, and Toxics Division, Region 6
Director, Air and Toxics Division, Regions 7, 8, 9, 10

cc: Chief, Pesticides and Toxics Substances Branch,
Regions 1, 2, 4, 5, 10
Chief, Toxics and Pesticides Branch, Regions 3 and 7
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AGENCY GUIDANCE ON RESIDENTIAL LEAD-BASED PAINT, LEAD-CONTAMINATED DUST, AND LEAD-CONTAMINATED SOIL

July 14, 1994

Recently EPA has received an increasing number of requests for advice on residential lead-based paint hazards, including hazards from lead-contaminated dust and soil in and around homes. These requests have come from State and EPA Regional officials, as well as from public health and housing personnel, concerned with childhood lead poisoning. While the Agency is in the process of developing a rule to identify these hazards under section 403 of the Toxic Substances Control Act (TSCA), 15 USC 2683, we believe it is appropriate to respond to these requests by issuing guidance at this time based upon our best currently available information.

EPA believes that it would not be prudent to issue national regulatory standards under section 403 at this time since a number of relevant research activities are currently underway and are scheduled to be completed in the near future. It is expected that this research will allow the Agency to develop standards that would more accurately direct resources toward residences that would benefit most from abatement and control activities. In the interim, the recommendations in this document represent the Agency's best judgement given its current state of knowledge and experience and are intended to serve as guidance until the promulgation of the TSCA section 403 rule. EPA emphasizes that these recommendations are intended solely as guidance and, as such, are not intended, nor can they be relied upon, to create any obligation or right that may be created in the future by rules issued under TSCA section 403. Persons to whom this guidance is directed may decide to follow it or to act at variance with it and may use the guidance in conjunction with analysis of specific site circumstances. The Agency also reserves the right to change this guidance at any time without public notice.

Use of This Guidance

It is the Agency's intent that this guidance be used to prioritize primary prevention activities that address hazards from lead in and around residences. EPA expects that these hazards will be among those that will be identified when regulations are issued under TSCA section 403. The levels and conditions described in this guidance should be used by decisionmakers (risk assessors, risk managers, etc.) to identify lead-based paint hazards, sources of lead exposure, and the need for control actions in residential environments where children may be present. They should not be regarded as definitive statements of the lead hazard associated with specific environmental lead measurements, but the Agency believes that the

criteria provided herein can inform and guide decisions on the identification of lead-based paint hazards and appropriate responses. Also, any lead-based paint-related activities (including lead detection, abatement, clearance, and disposal) should comply with all Federal, State, and local regulations.

Additionally, it should not be inferred that the recommendations in this guidance will, in and of themselves, guarantee the elimination of risks to children from residential lead exposure. Rather, this guidance is an attempt to identify the general types of environmental conditions and response activities that, given the current state of our knowledge, are likely to reduce risks over various broad ranges of environmental lead levels that may be found in the residential environment.

Finally, this guidance is not to be applied in addressing potential threats from lead at CERCLA and RCRA Corrective Action sites. Guidance developed by the Office of Solid Waste and Emergency Response is the appropriate tool for addressing these types of sites.

General

Although considerable progress has been made in the reduction of environmental lead (*e.g.*, the phase-out of leaded gasoline and lead-soldered food cans, more stringent drinking-water standards, *etc.*), residual lead contamination remains ubiquitous in both residential and commercial areas. In this guidance, the Agency's approach is to focus on the *sources* of lead that are related to the nation's housing stock. While there are numerous pathways for lead exposure, eliminating or reducing the role of lead-based paint and lead-contaminated soil as direct exposure sources (and as contributors to indoor lead dust) will significantly reduce total lead exposures from residential sources.

Soil and dust at other locations (*e.g.*, day care centers, public playgrounds, and other non-residential areas) can also be important contributors to a child's lead exposure. While these areas are outside the scope of TSCA section 403 authority, their potential contribution to a child's total lead exposure should also be considered when deciding upon community-wide responses to environmental lead.

In addition, the Agency recognizes that a number of factors contribute to risks from lead, including the nature of the lead sources, the amount of exposure to each source, and others. In this guidance, the Agency is using the levels of lead (and, for soil, the expected extent of children's contact) as a surrogate for risk.

At low to moderate levels of lead in soil and dust, and where paint deterioration is not extensive nor substrate failures or moisture problems present, EPA believes that interim controls[1] can be an effective way to temporarily reduce exposures. Interim control of lead in dust, soil, or painted surfaces must be predicated upon demonstrated ability to maintain and monitor such management strategies, based upon condition of the environment, expected use and contact, and reasonably anticipated changes in condition and/or use. At higher lead levels in soil and dust, and under deteriorated conditions of lead-based painted surfaces, more rigorous and long-term exposure reduction interventions should be taken. Under certain conditions related to extremely high soil concentrations or structural damage to painted surfaces, interim controls may not be appropriate for particular areas or components and only complete abatement of the component by an adequately trained professional will ensure adequate protection.

EPA policymakers do not believe that they are in a position to identify these levels and conditions as regulatory standards at this time. However, the Agency has developed this guidance based on consideration of estimated health impacts from lead exposure, the need to prioritize residences that would benefi from abatement, and comparison of risk reduction benefits and cost allocation projected for various control measures.

Sequence of Source Control Activities

Because of the interrelationship between lead-based paint, lead-contaminated dust, and lead-contaminated soil (*e.g.*, lead in paint can contribute lead to dust and soil, lead in soil can contribute lead to interior dust, *etc.*), it is important that the sources of lead be considered in proper order when conducting response activities. For example, if soil is being contaminated by deteriorating exterior lead-based paint, it is preferable to address the paint first, immediately followed by the soil. If the soil were addressed first, it may become recontaminated during work on the paint. In general, exterior paint should be addressed prior to soil, while soil and interior paint should be addressed prior to interior dust. This best avoids potential recontamination problems among the three. Exceptions should be made when there will be delays in addressing a source or when levels in one medium (such as interior dust) are clearly hazardous and immediate actions are needed to protect health. If, in the previous example, the exterior paint could not be

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[1] "Interim controls" means a set of measures designed to reduce temporarily human exposure or likely exposure to lead-based paint hazards, such as paint repair, specialized cleaning, temporary containment and ongoing monitoring of lead-based paint hazards or potential hazards.

addressed immediately for some reason, it would not be appropriate to delay attention to the soil, since the soil could continue to act as a source of exposure.

Lead-Based Paint

Lead-based paint is of concern both as a source of direct exposure through ingestion of paint chips, and as a contributor to lead in interior dust and exterior soil. Lead was widely used as a major ingredient in most interior and exterior oil-based paints prior to 1950. Lead compounds continued to be used as corrosion inhibitors, pigments, and drying agents from the early 1950's. In 1972, the Consumer Products Safety Commission limited lead content in new residential paint to 0.5% (5000 ppm) and, in 1978, to 0.06% (600 ppm).

The Department of Housing and Urban Development (HUD) estimates that three-quarters of pre-1980 housing contain some lead-based paint. The occurrence, extent and concentration of lead-based paint increase with the age of the housing. 90% of privately-owned housing units built before 1940 contain some lead-based paint; 80% of 1940-1959 units; and 62% of 1960-1979 units.[2]

Coatings of residential paint are defined by statute to be lead-based if the lead content exceeds either 1.0 mg/cm^2 or 0.5% by weight. Lead-based paint should be either abated or addressed through interim controls if it is found in any of the following circumstances: (1) it is deteriorated (in any location); (2) it is present (in any condition) on impact or friction surfaces; or (3) it is present (in any condition) on surfaces that are accessible for mouthing or chewing by children. "Deteriorated paint" means any interior or exterior paint that is peeling, chipping, chalking, or cracking, or is located on an interior or exterior surface or fixture that is damaged or deteriorated. An "impact surface" is an interior or exterior surface that is subject to damage from repeated impacts (*e.g.*, certain parts of door frames). A "friction surface" is an interior or exterior surface that is subject to abrasion or friction (*e.g.*, certain window, floor, and stair surfaces). A surface is considered to be accessible for mouthing or chewing by children if it protrudes from the surrounding area to the extent that a child can chew the surface, and is within three feet of the floor or ground (*e.g.*, window sills, railings, and the edges of stair treads). (Recommendations for sampling of painted surfaces are attached.)

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[2]Comprehensible and Workable Plan for the Abatement of Lead-Based Paint in Privately-Owned Housing: A Report to Congress, U.S. Department of Housing and Urban Development, Washington, DC, December 7, 1990.

When it is determined that paint abatement[3] and/or interim control activities will be performed on housing components, they should be performed according to practices that will be described in the 1995 HUD Guidelines[4] and the regulations to be promulgated under section 402 of TSCA, 15 USC 2682 (as appropriate for the unit in question), including clearance testing. The section 402 standards are expected to be proposed in several months. (Guidance on sampling and analysis of dust for clearance testing is attached.) Until either the HUD Guidelines are published in final form or the section 402 standards are issued, abatement activities should be performed according to the current HUD guidelines and interim control activities should be conducted according to state and local requirements, since they are not addressed in the existing HUD guidelines.

Lead-Contaminated Dust

In many cases, lead-contaminated interior dust can be the most direct source of a child's lead exposure, acting as a pathway for lead from lead-based paint, exterior soil, dust carried home from occupational exposure, etc. This guidance primarily confronts this source by addressing the residence-related sources of lead in dust--namely, lead-based paint and soil. The effect of the recommendations for paint and soil is removal or control of these two sources, followed by cleanup of the previously contaminated dust.

In the context of their lead abatement programs, HUD has established "clearance levels," which are part of the evaluation

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[3]"Abatement" means any set of measures designed to permanently eliminate lead-based paint hazards, including the removal of lead-based paint and lead-contaminated dust, the permanent containment or encapsulation of lead-based paint, the replacement of lead-painted surfaces or fixtures, and the removal or permanent covering of lead-contaminated soil.

[4]HUD is developing detailed technical guidelines pursuant to section 1017 of Title X of the Housing and Community Development Act of 1992 to describe best practices for all activities related to the evaluation and control of lead-based paint hazards. While applicable specifically to federally-assisted housing, the described practices provide useful technical guidance for all types of housing with similar conditions. These Guidelines are now undergoing clearance and approval within HUD and are available in draft form for review. These Guidelines will supersede HUD's 1990 "Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing," which focused primarily on testing and abatement (and do not address risk assessment or interim controls).

of the thoroughness of abatement and subsequent cleanup activities. Clearance levels are "technology based"--that is, they indicate what can be achieved after proper abatement or interim control actions. Clearance levels are appropriate since the marginal cost of attaining them is typically quite low once an intervention is underway, and EPA and HUD experience indicates that they can be achieved through proper abatement and interim control activities. The Agency therefore recommends that the following clearance levels be met after abatement or interim control activities have been performed:

Location	Lead Loading
Uncarpeted Floors[5]	100 $\mu g/ft^2$ (0.93 mg/m^2)
Interior Window Sills	500 $\mu g/ft^2$ (4.65 mg/m^2)
Window Wells	800 $\mu g/ft^2$ (7.45 mg/m^2)

Section 403 directs the Agency to issue rules that identify lead-based paint hazards, which include lead-contaminated dust that would result in adverse health effects. The levels that will be developed in the section 403 rulemaking will indicate to risk assessors that a lead-based paint hazard (for dust) exists. Obviously, the levels will be different in purpose than clearance levels--the former indicating that a hazard is present and the latter indicating that source control and cleanup have been appropriately performed. Accordingly, hazard levels are to be used during risk assessment and re-evaluation, whereas clearance levels are used to confirm the success of abatement and/or interim control activities.

Until the standards can be developed under section 403 the above-listed clearance levels should be used in identifying lead-based paint hazards and sources of lead exposure, and determining the need for control actions. The Agency reiterates that these recommendations are based upon lead levels that have been demonstrated to be achievable through abatement and interim control activities and they are not based upon projected health effects associated with specific dust lead levels. As a result of continued Agency evaluation of the relationship between interior dust lead levels and health effects, these hazard levels

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[5]It is anticipated that the 1995 revision to the HUD guidelines will lower the current clearance standard of 200 $\mu g/ft^2$ for uncarpeted floors to 100 $\mu g/ft^2$.

may be revised in future guidance.[6] Also, when assessing multiple sources of lead, dust lead concentration may be a more appropriate measurement. The utility of concentration measurements for identifying section 403 hazards from dust will be further considered in the development of the section 403 rulemaking.

Other potential sources of lead that may be present in house dust in addition to lead-based paint and lead-contaminated soil include neighborhood sources, such as demolition of a nearby building, sandblasting of a bridge, or other activities involving structures that may contain lead-based paint. Also, lead may be brought into the home on clothing of residents employed in lead-related occupations, or as the result of some hobbies. Additionally, deteriorated paint which contains some lead, but at levels lower than 1.0 mg/cm^2 or 0.5% by weight, could be a source. Depending upon the extent to which these sources contribute lead to interior dust, regular cleaning of the residence may not provide sufficient reduction in the level of lead exposure from dust, and the sources should be identified and controlled. It is often possible to identify these situations through sampling and analysis of the interior dust.

Since lead levels measured by wipe samples ("dust lead loading") are dependent upon both the amount of collectable dust on a surface and the concentration of lead in that dust, high values for either of these two factors could produce high wipe sample lead results. That is, a large amount of low-lead-concentration dust and a small amount of high-lead-concentration dust could result in similar wipe sample results. Therefore, while low dust lead loading values may indicate that sources that contribute to household dust have been sufficiently controlled, high values could result from any of the following situations: (1) there are some insufficiently controlled sources that continue to contribute significant amounts of lead to the dust; (2) relatively large amounts of low-lead dust are present; or (3) some combination of these occurs.

Dust lead concentration measurements can provide insight as to which of these conditions is resulting in high wipe sample values, as well as assist risk assessors in identifying possible sources. For example, if interior paint has been ruled out as a source, and dust concentrations approach those of exterior soil,

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[6]Principal among the studies expected to provide further information on the relationship between dust lead and children's blood lead levels is the recent Rochester Lead-in-Dust study. This HUD-funded study was conducted by the University of Rochester from May to December of 1993 and included approximately 200 children whose primary source of lead exposure was from house dust. Peer review of this study began in June of 1994.

it may well be the result of soil being tracked into the house from outside. Also, if paint is in sound condition and soil concentrations are low but the interior dust concentrations are high, it is possible that other sources, such as dust carried home from lead-related work, are present. Through a systematic process of elimination, many of the sources of lead in house dust can often be determined. While a detailed discussion on how to perform these types of assessments is outside the scope of this guidance, these issues will be addressed by certification procedures and training requirements for parties involved in lead-based-paint activities (which includes abatement, inspection and risk assessment) currently being developed under section 402 of TSCA.

To ensure that excessive exposures are not being caused by the *amount* of dust in the house, the Agency recommends that efforts always be made to minimize dust in residences, even after paint and dust sources have been addressed through any needed interim control and/or abatement activities. A key component of these efforts is the need to maintain a residence in a cleanable state (*i.e.*, in such a condition that it can be effectively cleaned by the occupant using reasonable cleaning procedures). For example, water-damaged or worn wood flooring may have a rough surface with crevices from which dust cannot be readily removed through routine wet mopping. Such surfaces should either be replaced or repaired so that they are cleanable. Likewise, it is important that the residence be effectively and regularly cleaned and that exposures to any interior dust be minimized. Recommended activities to reduce interior dust lead levels and associated exposures include: mopping floors, window ledges, and accessible surfaces with a warm detergent solution; washing pacifiers and bottles if they fall on the floor; washing toys and stuffed animals regularly; and ensuring that children wash their hands before meals, naps, and bedtime. These activities, as well as the importance of nutrition and other factors relevant to children's risk from lead exposure, should always be stressed as part of public education and awareness programs, regardless of the measured lead concentration in any one medium.

Lead-Contaminated Soil

Lead-contaminated exterior bare soil is of concern both as a direct source of exposure through inadvertent ingestion due to children's normal hand-to-mouth activity, and as a contributor to indoor dust lead levels (*e.g.*, when tracked into a residence from outside).

Common sources of lead in residential soil include deteriorating exterior lead-based paint and historical airborne deposition onto the soil surface as the result of point source emissions or leaded gasoline. These sources have added substantially to the naturally occurring lead in soils, which

generally range from 5 - 50 parts per million[7]. Also, industrial sources such as smelters, recycling facilities, and mining activities can result in lead contamination at residential areas. This adds difficulty in relating lead levels in soil to potential health effects because lead from different sources may pose different levels of potential hazard. One apparent difference is the extent to which ingested lead originating from different sources is taken up into the body--that is, the bioavailability of the lead. Decisionmakers should consider this and any other available information when implementing the recommendations contained in this guidance, particularly where non-paint sources of lead are involved. That is, if the soil is contaminated by lead from other sources, rather than lead-based paint, decisionmakers should investigate the types of lead compounds present and their unique characteristics. Agency guidance on consideration of bioavailability of lead in risk assessment can be found in the Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (available from National Technical Information Service, U.S. Dept. of Commerce, Attn: Sales, Springfield, VA 22169 (703/487-4650), as document number PB 93-963510).

Soil lead concentrations in the United States vary widely, from less than one to tens of thousands of parts per million (ppm). This range of concentrations and attendant potential exposure levels indicates that it is appropriate to develop a scaled strategy of risk reduction activities, depending upon the concentrations at particular locations and other site-specific factors. The Agency's recommendations for response activities at varying soil lead concentrations are as follows.

The Agency is recommending that (depending upon use patterns, populations at risk, and other factors), when lead concentrations are observed that exceed 400 ppm in bare soil, further evaluation should be undertaken and physical exposure-reduction activities, commensurate with the expected degree of risk, are appropriate.[8] The Agency believes that the 400 ppm

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[7]U.S. Environmental Protection Agency (1989) Review of the National Ambient Air Quality Standards for Lead: Exposure Analysis Methodology and Validation. U.S. EPA Office of Air Quality Planning and Standards, RTP, NC. EPA-450/2-89/011.

[8]The selection of 400 ppm in this guidance is based upon two decisions. The first is that the level should help in reducing the threat that environmental lead poses to the public. In this guidance, EPA estimates that beginning exposure reduction activity at 400 ppm will help ensure that a typical child or group of children exposed to lead would have an estimated risk of no more than 5% of exceeding a blood lead level of 10 µg/dl. This benchmark may change in the future section 403 rulemaking.

The second decision is to use the best available tool for assessing the relationship between children's blood lead levels and environmental lead levels. Current research indicates that young children are particularly sensitive to the effects of lead and require specific attention in the development of lead standards. A level that is protective for young children is expected to be protective for older population subgroups. In the same environmental setting, pregnant women would be expected to have blood lead levels lower than would young children, and this may further limit fetal exposures.

The Agency has examined both epidemiological studies and modeling approaches for this purpose. Both of these will be further evaluated as part of the effort to develop section 403 rulemaking. However, given the need to issue guidance at this time, the Agency is choosing to base the guidance on the Integrated Exposure Uptake Biokinetic (IEUBK) model, which EPA designed to evaluate exposures to children in a residential setting.

In general the model generates a probability distribution of blood lead levels for a typical child, or group of children, exposed to a particular soil lead concentration and concurrent lead levels from other sources. The spread of the distribution reflects the observed variability of blood lead levels in several communities. This variability arises from several sources, including behavioral and cultural factors.

The identification of lead levels from other sources (due to air, water, diet, etc.) is an essential part of characterizing the appropriate blood lead distribution for a specific neighborhood or site. For the purpose of deriving the 400 ppm value used in this guidance, the background lead exposure inputs to the IEUBK model were determined using national averages, where suitable, or typical values. Thus, the estimated level of 400 ppm is associated with an expected "typical" response to these exposures, and should not be taken to indicate that a certain level of risk (*e.g.*, exactly 5% of children exceeding 10 µg/dl blood lead) will be observed in a specific community (*e.g.*, in a blood lead survey).

Because a child's exposure to lead involves a complex array of variables, because there is population sampling variability, and because there is variability in environmental lead measurements and background levels of lead in food and drinking water, results from the model may differ from results of blood lead screening of children in a community. Extensive field evaluation of the model is in progress and the model will be evaluated further once these efforts are completed. EPA may base the future section 403 rulemaking on the model once these

level serves as a reasonable current benchmark for the purposes of this guidance. Therefore, the Agency recommends that further evaluation and appropriate exposure-reduction activities be undertaken when soil lead concentrations exceed 400 ppm at areas expected or intended to be used by children.' (Recommendations for soil sampling and analysis are attached.) Further evaluation activities may include blood lead screening of children and others in the community.

When soil lead levels exceed 400 ppm and children are likely to be present, exposure-reduction responses should focus on interim controls designed to change use patterns and create barriers between children and contaminated soil. This involves taking steps to keep children away from certain areas and to reduce exposure to bare soil in accessible areas. As an example of changing the use pattern, thorny shrubs can be planted to keep children from playing around houses that have elevated soil lead concentrations immediately next to the house. Also, play equipment can be moved from bare soil contaminated areas to encourage children to play elsewhere or, for more highly contaminated areas, access can be restricted by fencing. As an example of the use of barriers to reduce exposure, grass or other groundcover can be established and maintained or the area can be covered with mulch or gravel. While the effectiveness of many of these interim control actions cannot yet be quantified, the Agency believes that they can reduce exposure. However, whenever interim controls are used, their condition should be monitored to ensure continued effectiveness. For example, the condition of plants, groundcover, *etc.*, that serve as use-modifying and barrier-type elements should be visually inspected to ensure that they have become well established and remain effective at preventing exposure in accordance with the upcoming HUD Guidelines.'

Within the range of 400 - 5000 ppm, the degree of risk reduction activity should be commensurate with the expected risk posed by the bare soil, considering both the severity of exposure (as reflected by the soil lead concentration) and the likelihood of children's exposure. At concentrations in the lower segment

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evaluations have been completed, or on another methodology.

'400 ppm is also used as the residential soil lead screening level for corrective Action under the Resource Conservation and Recovery Act (RCRA) and cleanups under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) in the Office of Solid Waste and Emergency Response (OSWER) Interim Soil Directive. OSWER's screening level is not a "cleanup standard," nor automatically a "cleanup goal." Rather, it is a level of contamination above which there is enough concern to warrant site-specific study of risks.

of this range (e.g., between 400 ppm and 2000 ppm), emphasis should be placed on reducing exposures through interim controls at those areas expected or intended to be used by children. If the area is not frequented by children, these exposure reduction activities may be less rigorous. Where bare-soil lead levels are found to be 2000 parts per million or more, interim controls should be implemented even if the area is not frequented by children.

Increasingly aggressive exposure-reduction activities are warranted at higher soil lead levels, with very high levels indicating that soil abatement may be necessary. For purposes of prioritizing abatements, the Agency recommends soil abatement when lead levels are found at 5000 parts per million or more in residential bare soil. Appropriate activities at this level of lead concentration may include removal and replacement of the soil, the use of more permanent covers (*e.g.*, paving), or other activities. Of course, state and local agencies should consider any other factors that affect the actual risks and benefits of abatement when determining whether abatements may be necessary at lower levels, including, for example, prevalence of elevated blood lead levels in children.

The Agency is suggesting 5000 ppm for this higher level because of the need to prioritize the types of activities that can often be resource intensive. Factors considered in the choice of this level include the risk reduction that may be achieved by different measures and the resources needed to reduce those risks. Consequently, this level is designed to indicate where there is a relatively higher certainty that abatement or other extreme activities would be appropriate from a risk reduction and resource prioritization perspective. Based upon estimates of residential soil lead distributions (from HUD, 1990), 5000 ppm would target the soil at an estimated 1/2% of U.S. homes.

Because of the likelihood that lead-contaminated soil will have previously contributed lead to interior dust, specialized cleaning is recommended for the interior of residences to meet dust clearance levels after soil abatement or interim control activities have been conducted.

The Agency's recommendations for residential lead-contaminated soil are summarized in Table I.

Table 1--EPA Recommendations for Response Activities for Residential Lead Contaminated Bare Soil		
Area of Concern	Bare Soil Lead Concentration (ppm)	Recommended Response Activities
Areas expected to be used by children, including: ▸ residential backyards, ▸ daycare and school yards, ▸ playgrounds, ▸ public parks, and ▸ other areas where children gather.	400 - 5000	Interim controls to change use patterns and establish barriers between children and contaminated soil, including: ▸ planting ground cover or shrubbery to reduce exposure to bare soil, ▸ moving play equipment away from contaminated bare soil, ▸ restricting access through posting, fencing, or other actions, and ▸ control further contamination of area. Monitor condition of interim controls. Public notice of contaminated common areas by local agency.
	> 5000	Abatement of soil, including: ▸ removal and replacement of contaminated soil, and ▸ permanent barriers. Public notice of contaminated common areas by local agency.
Areas where contact by children is less likely or infrequent	2000 - 5000	Interim controls to change use patterns and establish barriers between children and contaminated soil, including: ▸ planting ground cover or shrubbery to reduce exposure to bare soil, ▸ moving play equipment away from contaminated bare soil, ▸ restricting access through posting, fencing, or other actions, and ▸ control further contamination of area. Monitor conditic.. f interim controls. Public notice of contaminated common areas by local agency.
	> 5000	Abatement of soil, including: ▸ removal and replacement of contaminated soil, and ▸ permanent barriers. Public notice of contaminated common areas by local agency.

Relationship of Soil Levels in This Guidance to the OSWER Interim Soil Lead Directive.

A variety of Agency programs address lead under a number of statutes. Lead in soil is addressed under TSCA Title IV (including TSCA sections 402 and 403), the RCRA Corrective Action program, and CERCLA (Superfund), each of which differs somewhat in purpose and in the types of sites to which they apply. Title IV section 403 regulations, which have yet to be issued, will identify lead hazards in paint and residential dust and soil. RCRA Corrective Action applies to RCRA hazardous waste sites. CERCLA applies to sites that have been contaminated by releases of CERCLA hazardous substances (which include lead).

While this guidance applies to housing, which is a significant part of the coverage of TSCA Title IV, it is not issued under the legal standards of any of these statutes, nor is it to be used to support statutorily driven requirements of CERCLA or RCRA. Instead, the guidance is designed to allow screening of the worst sources of lead-contaminated soil related to the housing stock among the potentially huge number of sites affected. The top one percent of housing sites consists of about 1,000,000 locations.

Because there is such a large number of housing sites, the purpose of this guidance is to recommend a set of nationwide levels that will screen those sites at which, EPA expects, decisionmakers will want to consider various risk reduction activities. The higher the level and the more likely exposure will occur, the more aggressive the risk reduction activities undertaken should be. The ultimate decision, however, will be made locally by various federal, state and local officials, or by building owners, operators or occupants. These decisionmakers will need to consider a variety of issues, including the risk reduction to be achieved by different measures and the resources needed to reduce those risks. Given the wide applicability of this guidance, EPA has developed generic standards to deal with the most risky sites--in particular, those where the Agency feels most confident that actual adverse effects could occur.

The Agency's recommendations for evaluating RCRA Corrective Action and CERCLA sites are contained in the OSWER Interim Soil Lead Directive. The OSWER directive deals with a much smaller number of sites, at which extensive site characterization will have been performed before cleanup decisions are made. RCRA and CERCLA programs, thus, will often have site-specific exposure values, which may be in a relatively narrow range. As a result, values chosen for action under the RCRA or CERCLA programs may be different from those selected under this guidance. Also, once the section 403 regulations are promulgated, OSWER intends to issue a final (to replace the interim) directive.

The Section 403 Rulemaking

At present, the Agency's section 403 rulemaking activities are focused on a variety of technical issues related to more accurate assessment of the risks associated with residential lead-based paint, lead-contaminated dust, and lead-contaminated soil. These activities include continued analysis of models and slope studies, including evaluation of the range of environmental conditions over which they are adequate. Complicating factors include likely differences in the bioavailability of lead from different sources and the variability in dust lead levels on interior surfaces. Because the Agency's work on these issues involves ongoing as well as previously published research, additional time will be required before levels for lead-based paint hazards can be determined with more specificity and proposed in the section 403 rulemaking.

As a result of these additional investigations, the section 403 rulemaking may differ from this guidance in a number of areas. These may include the role of dust concentration (in addition to, or in place of, dust lead loading), the quantitative or relative degree of blood lead level reduction that may be targeted, methods to relate environmental lead measurements to expected blood lead levels, and holistic standards rather than specific levels for each exposure source.

Attachments

Guidance for Measuring Lead in Soil and Paint

Sampling and Analysis of Dust for Clearance Testing

GUIDANCE FOR MEASURING LEAD IN SOIL AND PAINT

July 1994

PREFACE

Lead-contaminated house dust is considered the most significant source of lead poisoning for the greatest number of children. All house dust contains some lead; the amount depends on lead contamination from other sources such as deteriorated lead-based paint and lead-contaminated soil. Millions of children live in dwellings with high dust-lead levels and routinely put dust-laden fingers, toys, and other objects into their mouths. Deteriorated lead-based paint and soil also may individually contribute significantly to a child's lead exposure if ingested. However, a more common scenario is the contamination of house dust by paint and soil and the child's subsequent ingestion of the contaminated house dust. One way to control high house dust lead levels and dust-lead exposure is to control the sources of lead that contaminate house dust, namely lead-contaminated bare soil and deteriorated lead-based paint.

SOIL SAMPLING OVERVIEW

Soil is a major reservoir of lead in our environment. It has been contaminated with lead from many years of airborne particulate fallout from automobile exhaust, from industrial sources, and from the extensive use of lead-based paint on residential housing and other structures. Children who play in bare soil may be directly exposed to lead. Soil tracked into the home (e.g., on shoes or by wind) contaminates house dust and, thus, may expose children through the dust medium. The purpose of this section is to assist the reader to develop and implement a soil sampling strategy to determine whether the soil outside of a dwelling poses a significant health hazard to children.

Because only areas of bare soil are considered likely lead hazards,[1] the focus of this guidance is to assess lead levels in areas of bare soil. While only bare soil needs to be sampled, a property owner may wish to have additional sites sampled if the ground covering on those sites may be disturbed by such activities as gardening or excavation.

A soil sampling strategy should be designed to:

- Identify the location of soil-lead hazards outside of the dwelling.
- Provide recommendations to the property owners or other interested parties on the best ways to control identified hazards.
- Do the assessment at an affordable price to enable most property owners in the United States to have such an assessment conducted.

Due to the diversity of housing stock in the U.S., residential soil-lead assessments must

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[1] Title X defines "Lead contaminated soil" as *bare soil* on residential property that contains lead at or in excess of the levels determined by the EPA to be hazardous to human health.

be done case by case. The federal government can provide only general guidelines on where to collect samples. Actual sampling locations are based on information obtained during a preliminary assessment of the property and on the professional judgment of the person collecting the samples.

If sample analysis costs were trivial, then numerous soil samples could be collected at each residence to fully characterize lead levels. But analytical cost, in the range of $15 per sample, is not trivial. Therefore, to keep costs affordable, the sampling strategy must limit the number of soil samples analyzed.

When collecting only a limited number of samples from a yard, the major source of uncertainty in the results is from collecting samples from very small areas relative to the total area of interest. Imagine that a single soil sample is collected from an unusually high, but small, lead-contaminated area, or from a small section of the yard that recently had lead-free potting soil spilled on it. Most of these variations are out of the control of or unknown to the person collecting samples. One simple approach to reduce this problem is to sample from larger areas.

The easiest and most cost-effective way to sample from larger areas is to collect *field composite samples*. A field composite sample consists of individual sub-samples collected from two or more locations and combined into one sample for analysis (the composite sample). When only a few samples can be feasibly analyzed at a residence due to time and money constraints, composite sampling offers a more cost-effective approach and provides more accurate information than collecting a few single location samples.

At least two composite samples per dwelling or building should be collected where bare soil is present. General sampling locations are as follows:

- one from bare soil in the child's principal play area(s) and
- one from bare soil areas in the front or back yard (if present) and/or from the foundation drip line.

Vegetable gardens, pet sleeping areas, and bare pathways are also potential sampling sites. depending on the situation.

Once sampling areas are identified, sub-sampling locations within these areas need to be determined. No more than ten sub-samples should be collected into one composite sample in composite samples may add extra costs to laboratory lead analysis.

Determining Collection Locations for Each Composite

Option A

Sub-sampling locations in bare soil play areas are selected by first sketching the area and then drawing a circle just encompassing the accessible bare area. A second circle is drawn inside the first with one-half the radius and three equally-spaced sampling locations selected at random on the inner circle. Soil sub-samples are then collected at each location. This process may be repeated for up to three bare soil play areas, if present.

To sample the building foundation or dripline, take four individual sub-samples. Where possible, given accessibility limitations and the availability of bare soil, each sub-sample should be located at random in a bare soil area at the dripline on a different side of the house. Composite the four individual foundation/dripline sub-samples into one sample for lead analysis. At other sampling locations in the yard, samples should be collected following the procedures for play areas.

Option B

Each composite sample should consist of bare area soil sub-samples collected from 3 to 10 distinct locations roughly equidistant from each other along an axis. For samples collected along the foundation dripline, sub-samples should be collected at least 2 to 6 feet away from each other. At other sampling locations, samples should be collected at roughly equidistant points along each axis of an "x" shaped grid.

Sampling Equipment and Methods

Samples may be collected using a coring tool to acquire the top 1/2 inch (or 1 centimeter) of the soil surface. Soil coring devices may not be useful in sandy, dry, or friable soil. In these cases, a stainless steel scoop or the lip of the sample container itself may be used.

If paint chips are in the core sample taken, they should be included as part of the sample. Paint chips should not be excluded from the soil sample, since they are part of the soil matrix. However, there should be no attempt to oversample paint chips. Following the detailed sampling procedures outlined in *Residential Sampling for Lead: Protocols for Sampling Lead Dust and Soil* (EPA, 1994), is essential to correctly apply the guidance provided here.

Interpreting Results

Bare soil, if highly contaminated with lead, is thought to be a significant hazard to children who play on it. It may also be a significant source of tracked-in or wind-blown lead that subsequently contaminates house dust. The level of hazard is determined by comparing the sampling results to the Section 403 soil lead guidance.

If duplicate composite samples are collected from the same bare soil area(s), the arithmetic average of the two lead levels should be compared to the Section 403 guidance. If non-composited individual samples are taken instead of composites, within an area expected to have relatively homogenous lead levels, the arithmetic average of the individual samples should be compared to the standard. However, individual samples above the standard might possibly indicate that there are inherently large differences in lead levels and that more sampling or some remediation should be considered.

SAMPLING AND TESTING FOR LEAD IN PAINT

Where to Sample

For a residential unit, all interior rooms, the exterior sides of the unit, and the outside property around the unit are to be inspected. The residence should be divided into room equivalents. Room equivalents are standard interior rooms, stairways and hallways which are not usually regarded as rooms, portions of very large rooms, each of the sides of the house, and the outside property. Within the room equivalents, painted components are to be identified and grouped by component type, substrate, and visible color. For example, if there are four walls in a room, all made of plaster, and all painted with white paint, these four walls are all grouped together. One wall of the four is to be randomly selected to represent the four walls. In similar fashion, the inspection continues in each room equivalent with the identification of unique combinations of component, substrate, and visible color. A random representative of each unique combination is to be sampled and tested in each room equivalent.

For each of these designated components, an area on the component is to be chosen which represents the paint on that component. During the inspection, components which are accessible surfaces, friction surfaces, impact surfaces, or have deteriorated paint are to be identified.

How Many Samples

It is expected that between 50 to 200 components will be identified for testing at a residential unit.

In multifamily housing with more than 20 units, a random sample of units for inspection is allowed. Units and buildings that have similar construction, floor plans, and painting history should be grouped for sampling purposes. Samples may be selected for each group. In multifamily housing with 20 or fewer units, each unit is to be sampled. In both cases, individual units are to be sampled following the guidance on where to sample described for residential units. The number of units in the sample should be determined from Table I, which

is attached. However, the decision logic for a sample of units is more complicated than for single residential units, and should be fully grasped before a sample is selected.

How to Sample

The recommended method for testing in a residential unit at this time is the K shell reading from a portable XRF instrument. Substrate corrections are to be made where necessary. Standard reference material paint films developed by NIST for usage with XRFs are to be used to demonstrate that XRF instruments are in control. XRF results are in units of milligrams per square centimeter.

An average of three readings is recommended. Each reading should be approximately 15 seconds with a new source. Appropriate adjustments in reading time should be made for source age.

Where portable XRF is not feasible due to a surface being narrow or curved, where greater accuracy is desired, or where comparison to the percent by weight standard is desired, paint samples can be collected and sent for to a laboratory for analysis. The paint samples should be collected from a one square inch area. Care should be taken to collect all the paint in the area, and to minimize the inclusion of substrate material. Lead in paint samples collected in this way can be reported in both milligrams per square centimeter and percent by weight. If a surface is so deteriorated that XRF is not feasible and a paint sample cannot be collect from a square inch, then a strip of peeling paint is to be collected. Lead from such a sample can only be reported in percent by weight units.

How to Analyze Paint Samples

Paint chip samples should be analyzed by a laboratory recognized by EPA's National Lead Laboratory Accreditation Program. Paint samples should be no more than 500 milligrams in weight. If the paint samples received by the laboratory are larger than 500 milligrams, the laboratory should homogenize and subsample the paint samples to select a subsample of approximately 500 milligrams for the analysis. Results reported by the laboratory must make the appropriate adjustment for the subsampling.

Conclusions

For single houses and units, conclusions are reached as follows. XRF results are to be corrected for substrate effects where necessary. Corrected XRF results are divided into three categories: positive, inconclusive, and negative. Reading averages of 1.6 mg/cm^2 or more are classified as positive; reading averages or 0.4 mg cm^2 or less are classified as negative. All other reading averages are classified as inconclusive. K-shell XRF results in the positive category indicate lead is present at or above 1.0 mg cm^2. K-shell XRF results in the negative category indicate lead is not present at or above 1.0 mg cm^2. The probability of false positives is currently estimated to be at least less than 10% and less than 5% in most cases. The

probability of false negatives is similarly estimated to be at least less than 10%, and less than 5% in most cases. Inconclusive results should be confirmed by laboratory analysis. Inconclusive XRF results on accessible, impact, friction or deteriorated surfaces should be regarded as positive for lead unless a subsequent laboratory test proves otherwise.

When paint chip laboratory results are reported in milligrams per square centimeter, a result greater than or equal to 1.0 is positive for lead. When the results are in percent by weight, a result greater than or equal to 0.5% is positive for lead. If laboratory results are in both units, and at least one result is above the 1.0 mg/cm^2 or 0.5% standard, then the sample is positive for lead.

Locations tested by XRF or paint chip sampling may represent other locations. Refer back to the original inspection to determine the housing components which the samples represent. Findings of positive, negative, or inconclusive apply to all the components represented by a sample.

For multi-family housing of 20 or more units where a sample of units has been selected, grouped the sample results by component type, such as "kitchen walls" or "doors". Each component type group should consist of at least 40 samples to the extent this is practical. Classify XRF results as positive, inconclusive, or negative following the rules above. For any component type with 20% or more positive results, lead is present at or above the 1.0 mg/sq on one or more of the components of that type. If all sample results are negative or all sample results are less than 1.0 mg/cm^2, lead is not present at or 1.0 mg/cm^2 on any components of that type. All other cases are inconclusive and require laboratory testing.

To do the laboratory testing, take a paint sample for all XRF sample results that were greater than or equal to 1.0 mg/cm^2. If any of these results are positive, reach the conclusion that lead is present at or above 1.0 mg/cm^2 on at least one component of the type in question. If no results are positive, reach the conclusion that lead is not present at or above 1.0 mg/cm^2 for any components of that type. Results from the sample can be used to determine which component types need abatement or control, which do not, and which need further testing in the unsampled units.

TABLE I
Number of Units to Be Tested in Multifamily Developments

Number of Units in Building or Group of Similar Buildings	Number of Units to Be Tested
21-26	20
27	21
28	22
29-30	23
31	24
32	25
33-34	26
35	27
36	28
37	29
38-39	30
40-50	31
51	32
52-53	33
54	34
55-56	35
57-58	36
59	37
60-73	38
74-75	39
76-77	40
78-79	41
80-95	42
96-97	43
98-99	44
100-117	45
118-119	46
120-138	47
139-157	48
158-177	49
178-197	50
198-218	51
219-258	52
259-299	53
300-379	54
380-499	55
500-776	56
777-1004	57
1005-1022	58
1023-1039	59

For buildings or groups of similar buildings with 1,040 units or more, test 5.8 percent of the number of units, rounded to the nearest unit. EXAMPLE: If there are 2,170 units, 5.8 percent is 125.86 units, so 126 units should be tested.

DUST CLEARANCE TESTING

July 1994

BACKGROUND

Section 403 of the Residential Lead-Based Paint hazard Reduction Act of 1992 requires EPA to promulgate regulations which identify lead-based paint hazards, lead-contaminated dust, and lead-contaminated soil. The purpose of this document is to summarize clearance testing procedures to identify lead dust hazards that may remain after lead abatements or application of interim controls.

WHO SHOULD SAMPLE

Clearance testing for dust should be conducted after lead abatements or after application of interim controls. Clearance testing should be conducted by a party independent of the person or organization that completed the abatement or interim controls.

WHEN TO SAMPLE

Sampling of dust should take place at least one hour after completion of all abatement and interim control work, including clean-up. All interior rooms or areas and exterior areas should be visually clean before collecting dust samples. If this is not the case, clean the rooms and areas before starting dust collection for clearance testing.

WHERE TO SAMPLE

Identify the interior rooms or areas and exterior areas of the residence where abatements or interim controls were carried out. If there was an interior containment area, most of the clearance sampling should be conducted within the containment area. If there was no interior containment area, all interior rooms or areas should be sampled. Designate rooms or areas in the interior for sampling. An interior area is a portion of a the residence that is equivalent to a room, even though it is not ordinarily regarded as such. Hallways and stairways are examples of areas in a house. In addition, very large rooms should be divided into areas.

If on-site paint removal took place in the interior, collect one floor sample, one interior window sill sample, and one exterior window sill sample from each of the interior rooms or areas designated for sampling. If no on-site paint removal took place in the interior, select one floor sample and one window sample, either a interior or exterior sill, in each room or area designated for sampling.

If there were any exterior abatements or interim controls, select one exterior window sill and one other horizontal surface in a living area or near an entryway for testing, preferably from the sides or exterior areas of the house where abatements or controls were applied. A porch railing or the top step of a stairway are examples of horizontal surfaces on the exterior.

If there was an interior containment area, collect one floor sample outside the containment area but within 10 feet of the airlock.

HOW MANY SAMPLES

The total number of samples will depend on the number of interior rooms, the presence of an interior containment area, whether there was any exterior work, the number of windows present, and the presence of horizontal surfaces on the exterior.

For example, consider a single family house with 8 interior rooms and areas. In this case suppose abatement had taken place in 4 of the interior rooms, and on the front and back of the house. There was no interior containment area, and on-site removal of paint took place in the interior. All rooms had windows. There would be 26 dust samples for this house, 3 from each of the 8 interior rooms or areas, and 2 from the exterior.

As another example, consider another house with 8 interior rooms or areas. Suppose abatement had taken place in the interior, in 5 rooms, with a containment separating these 5 rooms from the rest of the house. Suppose no on-site removal of paint had taken place. There would be 11 interior dust samples, 2 from each of the 5 rooms were abatements were done, plus one floor sample within 10 feet of the containment area. If there had been any exterior work, 2 dust samples would have been collected from the exterior.

In a multi-family housing of more than 20 units, random sampling of units for clearance testing is allowed. Units and buildings that have similar construction and were cleaned in the same manner should be grouped for sampling purposes. Samples may be selected for each group. The number of units in the sample should be derived from Table I, which is attached. In this case, guidance on where to sample for the selected units is the same as for an individual house. However, if any component in the sample of units fails clearance, that component, in all the unsampled units, must be re-cleaned, as well the specific components that failed clearance in sampled units. The significance of this aspect of clearance failure should be grasped before selecting a sample of units.

HOW TO SAMPLE

Draw or obtain a floor plan of the house or unit. Rooms, areas, and locations of windows should be clearly marked on the floor plan. If there were exterior abatements, identify the window exterior sills and horizontal surfaces closest to the exterior areas that were worked on. Using information about the abatement or interim control applications, designate interior rooms and areas and exterior areas for sampling.

Using the floor plan, go through the residence and make selections of where to sample. For floors, divide each room or area into three segments, randomly select one of the segments. and then, within the segment, randomly select either a position near a wall or a position near the center. If there is one window in a room or area, that window should be

sampled. If there is more than one sample, randomly select an interior window sill and/or and exterior window sill. Note that if there are two or more windows in a room, the interior and exterior sills may come from different windows.

The basic method for collecting dust clearance samples is the wipe method. Other dust collection methods may be used provided the user establishes comparability to the wipe method.

To collect floor samples, use a template or tape to mark off one square foot within the floor location selected. Use a wipe method to collect dust within the template or taped area. Clean the template between samples if using a non-disposable template. Take other appropriate steps to avoid contamination of samples.

For sampling interior and exterior window sills and exterior horizontal surfaces, use tape to mark the specific section to be sampled. Be sure what is delineated by the tape can be measured.

After collection of dust, fold the wipe and place it in a clean glass or plastic container. Label the container so that sample can be associated with the location from which it was collected. Measure all sampling areas not delineated by the template, and all cases indicate the sampling area on each label for each container.

HOW TO ANALYZE DUST SAMPLES

Dust samples are to be analyzed for "total lead", not "bioavailable lead". Samples should be analyzed at a laboratory recognized as proficient for lead in dust analysis by the EPA National Lead Laboratory Accreditation Program (NLLAP).

CONCLUSIONS

At this time, the standards for clearance are 100 ug/ft^2 for floors, 500 ug/ft^2 for interior window sills, and 800 ug/ft^2 for exterior window sills and exterior horizontal surfaces. These numbers are for wipe samples. If a collection method other than the wipe method is used, the user is responsible for providing comparable standards for clearance.

Samples which are less than the appropriate standard are said to have passed clearance, and all rooms or areas represented by those samples have passed clearance.

Samples above or equal to the appropriate standard have failed clearance, and all rooms or areas represented by those samples are said to have failed.

For samples that have failed, the components represented by those samples (floors, interior window sills, exterior window sills, exterior horizontal surfaces, or interior areas outside a containment area) must be re-cleaned and re-tested. The process continues until

clearance is obtained for all components. In addition, if a sample outside a containment area fails clearance, collect additional floor samples outside the containment area, at a further distance from the airlock, during the re-testing.

RE-EVALUATION SCHEDULE

When lead-based paint is removed during abatement, successful clearance testing after application is all that is recommended. When lead-based paint remains at the residence, re-evaluation testing is recommended in addition to clearance testing. For enclosures, re-evaluation testing is recommended ten years after treatment. For encapsulation, re-evaluation testing is recommended one year after application, and then every three years afterwards. For interim controls, re-evaluation testing is recommended every 12 months after application. If a mixture of methods is used in a room or area, the most stringent schedule for re-evaluation testing is recommended.

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54	34
55-56	35
57-58	36
59	37
60-73	38
74-75	39
76-77	40
78-79	41
80-95	42
96-97	43
98-99	44
100-117	45
118-119	46
120-138	47
139-157	48
158-177	49
178-197	50
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